AMENDMENTS TO THE SPECIFICATION:

Please amend the paragraph beginning at page 1, line 4 as follows:

The example embodiments of the present invention ~~relates~~ relate to a method and system for estimating the global motion between frames in a video sequence, and also to a method and system for generating panoramic images from video sequences using the global motion estimations. In particular global motion estimations and panoramic images are produced from video sequences comprising motion-compensated and inter-frame encoded image frames.

Please amend the paragraph beginning at page 1, line 10 as follows:

BACKGROUND ~~TO THE INVENTION.~~

Please amend the paragraph beginning at page 2, line 3 as follows:

In order to generate a panoramic image from these frames, it is necessary first to register the correspondence between each frame, that is, to decide for each frame how the image depicted therein relates to the images in the other frames. This problem is analogous to that familiar to jigsaw puzzle users and mosaic layers around the world, in that given a part of an image the correspondence of that part to the whole must be established. The situation with panoramic scene construction is further complicated in that the images significantly overlap, and may also be repeated (i.e. in the case where there is no camera movement or motion in the scene, then

multiple identical frames are produced). It is essentially this problem of image registration between frames which one aspect of example embodiments of the present invention addresses.

Please amend the paragraph beginning at page 2, line 21 as follows:

FIG. 2 illustrates an example panoramic image generated using a prior art "least mean squares" approach, which will be described later. The image is a background panorama of a football match, and specifically, that of the Brazil v. Morocco match of the FIFA 1998 World Cup Finals, held in France. Within the present specification, all Figures illustrating a video frame are taken from source MPEG video of this match. Within FIG. 2 it will be seen that a panorama of one half of a football pitch is shown. Many errors occur in the image, however, and in particular in respect of the lines which should be present on the pitch, in respect of the depiction of the goal, and in the depiction of the far side of the pitch. As will become apparent later, example embodiments of the present invention ~~overcomes~~ overcome many of these errors.

Please amend the paragraph beginning at page 4, line 28 as follows:

From FIGS. 5 and 6 it will be seen that generally most of the motion vectors are of substantially the same magnitude and direction, and hence are indicative that the majority of motion within the image is a global motion caused by a panning of the camera from right to left. However, some of the motion vectors are clearly in error, being either of too large a magnitude with respect to their adjacent vectors, being in the wrong direction, or with a combination of both deficiencies. It is the presence of these "bad" motion vectors which complicates the problem of

motion estimation directly from the motion vectors. This is one of the problems which an aspect of example embodiments of the present invention addresses.

Please amend the paragraph beginning at page 6, line 16 as follows:

Thus, global motion estimation from MPEG motion vectors has been performed previously, but problems have been encountered with the amount of noise present in the MPEG motion vector information which have required elaborate solutions. This problem of noise in the motion vector information is one of the problems which example embodiments of the present invention ~~intends~~ intend to overcome.

Please amend the paragraph beginning at page 6, line 22 as follows:

SUMMARY ~~OF THE INVENTION~~

Please amend the paragraph beginning at page 6, line 23 as follows:

The example embodiments of the present invention ~~provides~~ provide a method and system which overcomes the noise present in inter-frame encoded motion vectors to allow for global motion estimations between frames to be performed. This is achieved by detecting motion estimation failure, and re-calculating motion estimations along a different route from the anchor frame to the particular frame in question. This is made possible by the realisation that bi-directional frames in a coding scheme such as MPEG contain both forward and backward motion

vectors, and hence provide at least one alternative "route" following the motion vectors between frames from the particular frame to its anchor frame. Individual motion estimations can be made between each pair of frames on the route, and then the individual motion estimations accumulated to give an overall motion estimation. Thus, global motion estimation can be performed accurately for frames whose motion vectors are subject to high levels of noise in one direction, but not necessarily in another (in the case of B-frames), or for frames whose own motion vectors are too noisy, but for which there are motion vectors between the frame and another B-frame which are not too noisy (as in the case of P-frames).

Please amend the paragraph beginning at page 8, line 18 as follows:

In addition to the above, from a second aspect, example embodiments of the present invention also ~~provides~~ provide a method of generating panoramic images from a motion-compensated inter-frame encoded video sequence, the method comprising:

Please amend the paragraph beginning at page 8, line 25 as follows:

Thus the second aspect of example embodiments of the invention allows panoramic images to be generated using the global motion estimations provided by the first aspect. As the global motion estimations are substantially accurate, the panoramic images produced by the second aspect are of improved quality with respect to some prior art images.

Please amend the paragraph beginning at page 9, line 22 as follows:

From a third aspect, example embodiments of the present invention also ~~provides~~ provide a system for global motion estimation between frames of a motion-compensated inter-frame encoded video sequence, each inter-frame encoded frame of the sequence having a plurality of motion vectors encoded therein relating the frame to a preceding and/or succeeding frame of the sequence, the system comprising:

Please amend the paragraph beginning at page 10, line 13 as follows:

Within both the third and fourth aspects of example embodiments of the invention, corresponding further features and advantages as already described above in respect of the first and second aspects may respectively be provided.

Please amend the paragraph beginning at page 10, line 16 as follows:

From a fifth aspect, example embodiments of the present invention also ~~provides~~ provide a computer program or suite of programs arranged such that when executed on a computer system the program or suite of programs causes the computer system to perform the method of any of the first or second aspect. Moreover, from a further aspect there is also provided a computer readable storage medium storing a computer program or suite of programs according to the fifth aspect. The computer readable storage medium may be any suitable data storage device or medium known in the art, such as, as a non-limiting example, any of a magnetic disk, DVD, solid state memory, optical disc, magneto-optical disc, or the like.

Please amend the paragraph beginning at page 10, line 25 as follows:

Further features and advantages of example embodiments of the present invention will become apparent from the following description of an embodiment thereof, presented by way of example only, and with reference to the accompanying drawings, wherein like reference numerals refer to like parts, and wherein:

Please amend the paragraph beginning at page 11, line 7 as follows:

FIG. 7 is an illustration of a computer system which may form the operating environment of example embodiments of the present invention;

Please amend the paragraph beginning at page 11, line 13 as follows:

FIG. 10 is a flow diagram of an embodiment of a global motion estimation method according to one aspect of example embodiments of the invention;

Please amend the paragraph beginning at page 11, line 15 as follows:

FIG. 11 is a flow diagram of an embodiment of a panoramic image generation method according to another aspect of example embodiments of the invention;

Please amend the paragraph beginning at page 12, line 5 as follows:

FIG. 7 illustrates a general purpose computer system which provides the operating environment of the embodiment of the present invention. Later, the operation of example embodiments of the invention will be described in the general context of computer executable instructions, such as program modules, being executed by a computer. Such program modules may include processes, programs, objects, components, data structures, data variables, or the like that perform tasks or implement particular abstract data types. Moreover, it should be understood by the intended reader that example embodiments of the invention may be embodied within other computer systems other than those shown in FIG. 7, and in particular hand held devices, notebook computers, main frame computers, mini computers, multi processor systems, distributed systems, mobile telephones, and the like. Within a distributed computing environment, multiple computer systems may be connected to a communications network and individual program modules of example embodiments of the invention may be distributed amongst the computer systems.

Please amend the paragraph beginning at page 12, line 33 as follows:

It will be appreciated that FIG. 7 illustrates an exemplary embodiment only, and that other configurations of computer systems are possible which can be used with example embodiments of the present invention. In particular, the base chassis unit 100 may be in a tower configuration, or alternatively the computer system 1 may be portable in that it is embodied in a lap-top or note-book configuration. Other configurations such as personal digital assistants or even mobile phones may also be possible.

Please amend the paragraph beginning at page 28, line 1 as follows:

There are numerous applications of example embodiments of the invention, which cover a large area including video compression, video visualisation, video synthesis, and video surveillance. We list several specific, but non-limiting, uses below.

Please amend the paragraph beginning at page 28, line 4 as follows:

Firstly, example embodiments of the invention may be used to provide mosaic based video compression. Here, after a panoramic background is constructed, the static scene can be represented efficiently using JPEG style compression techniques, and especially when a video contains a dominant static scene. Only the segmented foreground objects/activities, or even more simply, only the difference between a frame and its reference region in the panoramic scene, need to be coded. This should prove very useful for very low bit-rate transmission and video storage.

Please amend the paragraph beginning at page 28, line 11 as follows:

Secondly, example embodiments of the invention may also be used for mosaic based visualisation. In such a case the panoramic background and foreground images are used to provide a better understanding about both the static scene and the whole event that takes place in a video. Furthermore, a video sequence can be visualised as a set of "key frame mosaics", each

encodes a continuous clip of the video. Obviously this is more representative than the conventional key frames.

Please amend the paragraph beginning at page 28, line 17 as follows:

A further use is in video synthesis. When combined with other techniques, such as image segmentation, the foreground activities as apparent from a foreground panorama can be extracted from a video against the panoramic background, the background panorama having been generated using example embodiments of the present invention. It is then possible to replace the background of the video with a different image therefore making the events in the video look as if they are taking place in another situation.

Please amend the paragraph beginning at page 28, line 23 as follows:

Another use of example embodiments of the invention is as a virtual camera. While an original video may not be taken in the perfect camera set-up (e.g. camera jigging or over-zooming), the ability to warp images to a reference frame and to perform accurate image registration as provided by example embodiments of the invention can allow a video image to be re-constructed from an ideal "virtual view".

Please amend the paragraph beginning at page 28, line 28 as follows:

Whilst example embodiments of the invention has been described herein as being implemented in software running on a computer system, it should also be understood that example embodiments of the invention could equally be implemented in hardware, for example for use in global motion estimation or panoramic image generation by hand-held digital cameras, camcorders, and the like. Such a hardware implementation would include suitable specific processors, other integrated circuits, memory and the like to perform the functions required by example embodiments of the present invention, and should be considered as functionally equivalent to the specifically described software embodiment.

Please amend the paragraph beginning at page 29, line 1 as follows:

In addition, throughout this description we have concentrated on the encoded video sequence being an MPEG encoded sequence, encoded according to any one of the MPEG standards. It is not, however, essential that the encoded video sequence be strictly MPEG encoded, as all that is required is an encoded video sequence which has been inter-frame encoded to produce motion vectors indicative of the general motion of a number of macroblocks which make up a frame with respect to a preceding or succeeding frame. Therefore, whilst the development of example embodiments of the invention has been based upon and is intended to encompass MPEG encoded video sequences, other video coding methods which provided the necessary motion vector information, but which may not be MPEG compliant may also be used to provide the encoded video sequence used by the invention.